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(54) **SYSTEM FOR INTERCEPTING SIGNALS TO BE TRANSMITTED OVER A FIBER OPTIC NETWORK AND ASSOCIATED METHOD**

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(51) **Int. Cl.**
H04B 10/00 (2006.01)

(52) **U.S. Cl.** **398/40**
(58) **Field of Classification Search** 398/40
See application file for complete search history.

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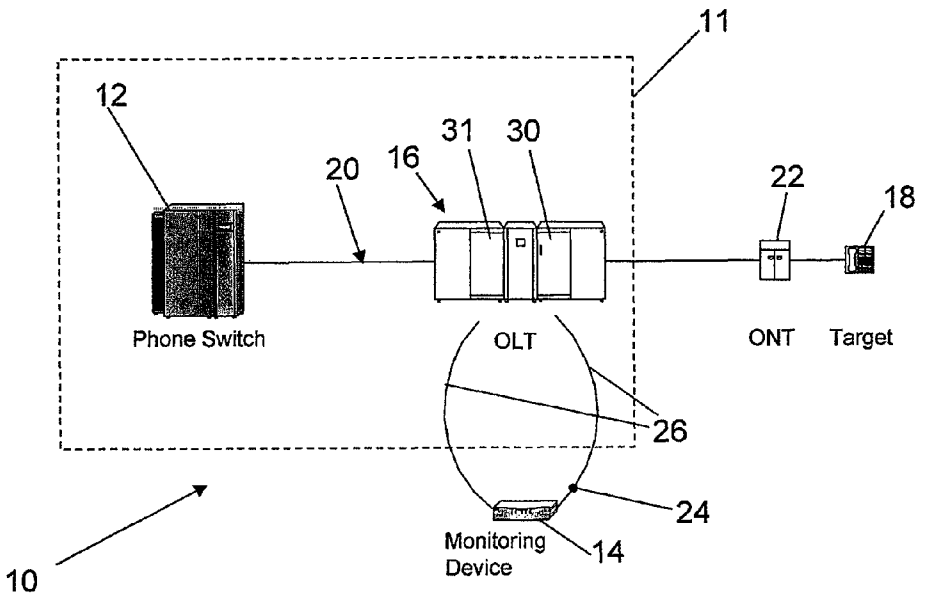
Primary Examiner — Nathan Curs
Assistant Examiner — Tanya Ngo

(57) **ABSTRACT**

A system is provided for intercepting signals transmitted between a target served by a fiber optic network and a subscriber. A network is described having a phone switch at a central office configured to receive signals for transmission to and from a target, such as the target of a criminal investigation. A signal received at the central office is assigned to an analog circuit, and a monitoring device configured to intercept and monitor the signal is installed along the analog circuit at a location that allows the monitoring of communications without notifying the target that he is under surveillance. After the signal has been monitored, it is converted to a digital signal for transmission. A method is also provided for intercepting a signal transmitted between the target served by a fiber optic network and a subscriber, such that a monitoring device may be installed without alerting the target.

20 Claims, 6 Drawing Sheets



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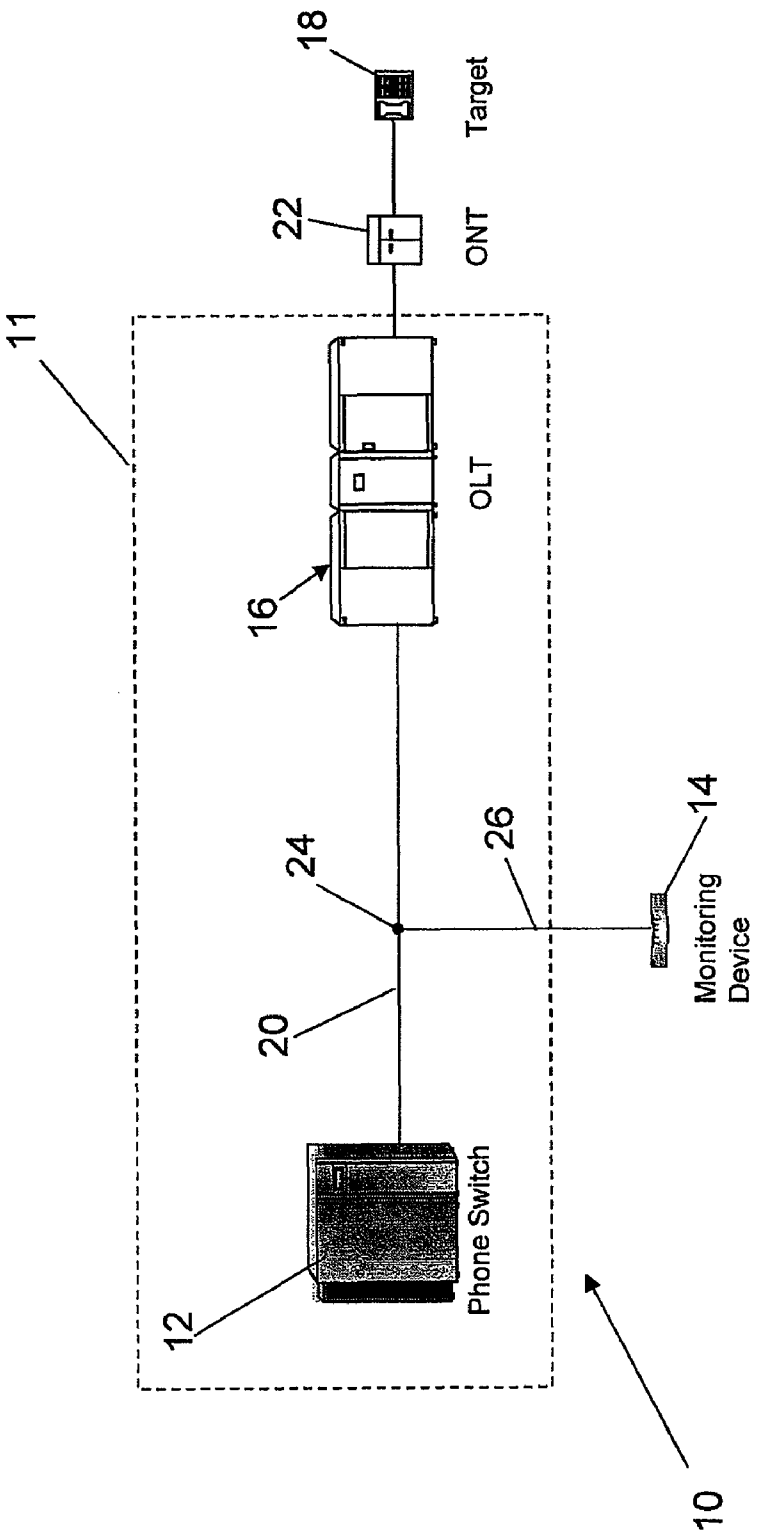
18
Target
22
ONT
11
OLT
16
24
26
14
Monitoring Device
20
Phone Switch
12
10

Fig. 1

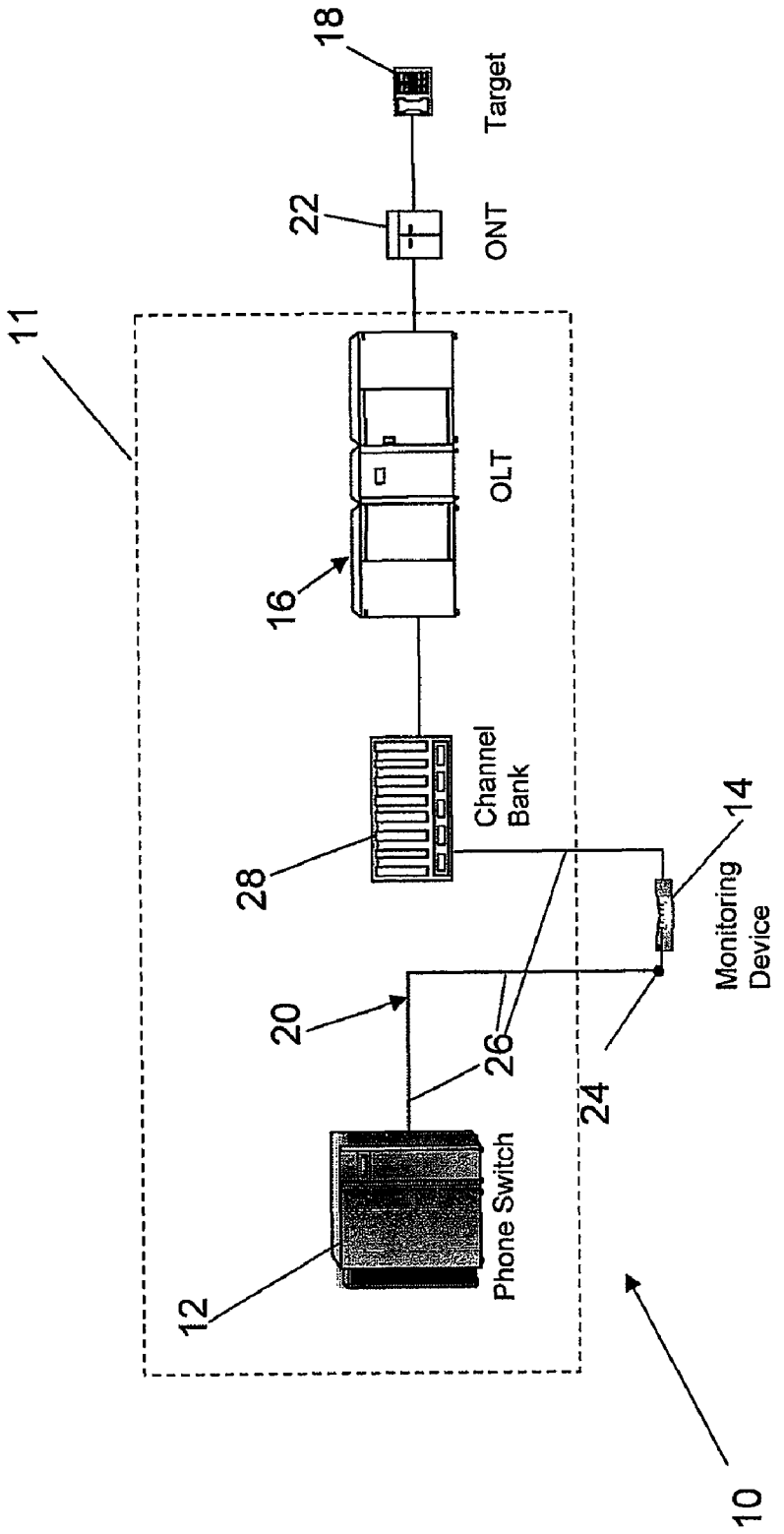
18
Target
22
ONT
11
OLT
16
Channel Bank
28
14
Monitoring Device
20
26
24
Phone Switch
12
10

Fig. 2

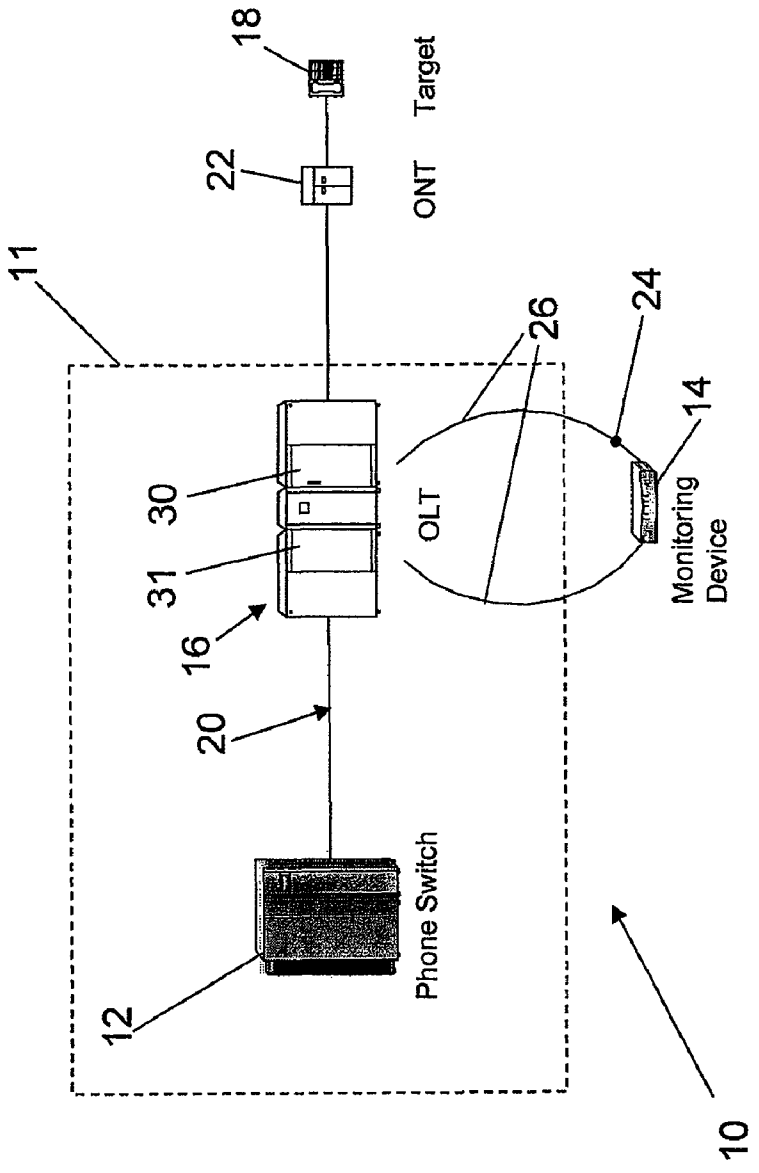
18
Target
22
ONT
11
26
24
14
30
OLT
Monitoring
Device
31
16
20
Phone Switch
12
10

Fig. 3

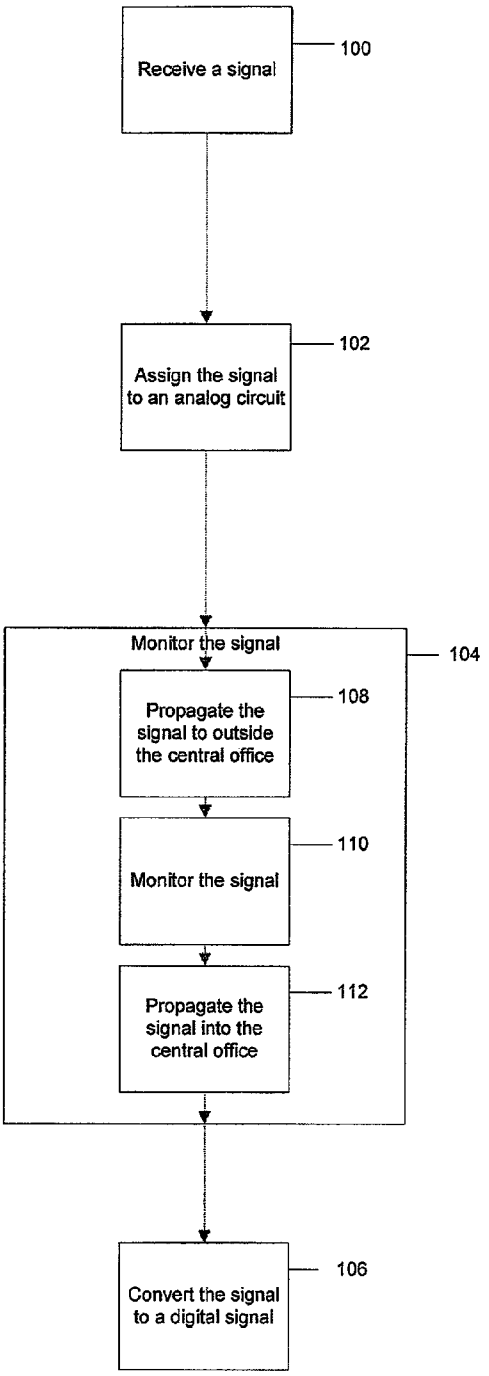
Receive a signal
100
Assign the signal to an analog circuit
102
Monitor the signal
104
Propagate the signal to outside the central office
108
Monitor the signal
110
Propagate the signal into the central office
112
Convert the signal to a digital signal
106

FIG 4

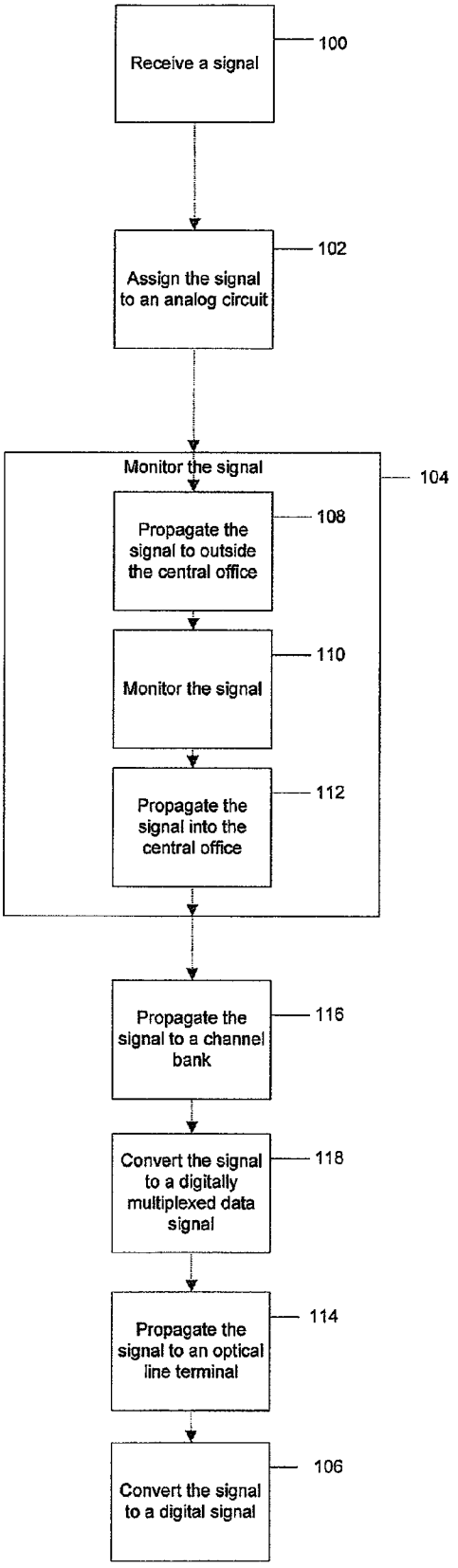
Receive a signal
100
Assign the signal to an analog circuit
102
Monitor the signal
104
Propagate the signal to outside the central office
108
Monitor the signal
110
Propagate the signal into the central office
112
Propagate the signal to a channel bank
116
Convert the signal to a digitally multiplexed data signal
118
Propagate the signal to an optical line terminal
114
Convert the signal to a digital signal
106

FIG 5

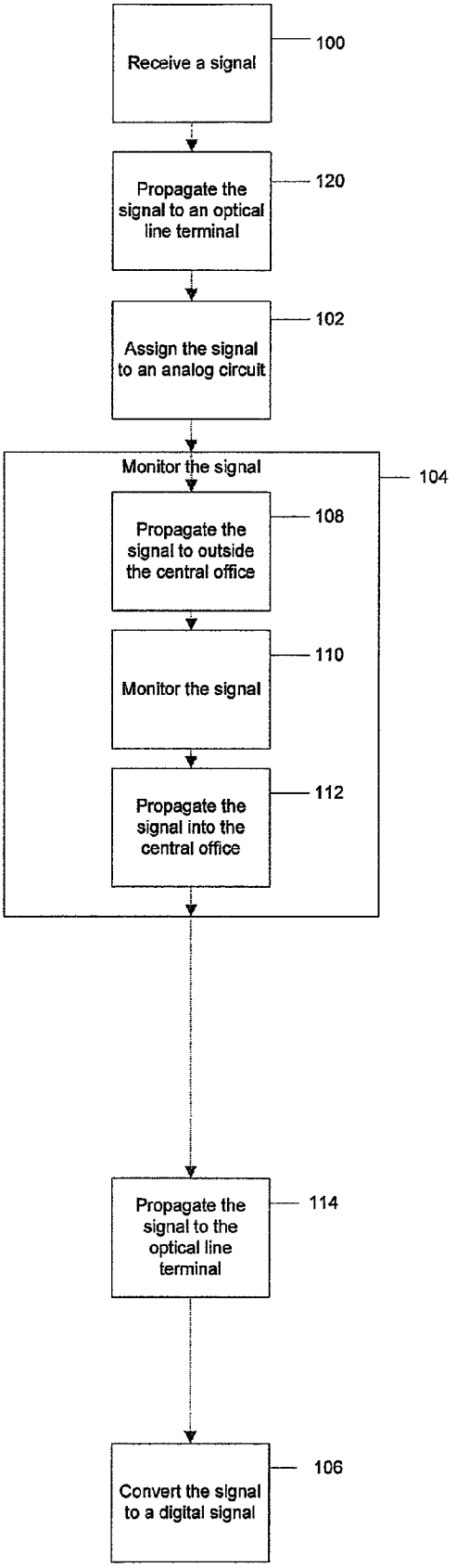
Receive a signal
100
Propagate the signal to an optical line terminal
120
Assign the signal to an analog circuit
102
Monitor the signal
104
Propagate the signal to outside the central office
108
Monitor the signal
110
Propagate the signal into the central office
112
Propagate the signal to the optical line terminal
114
Convert the signal to a digital signal
106

FIG 6

SYSTEM FOR INTERCEPTING SIGNALS TO BE TRANSMITTED OVER A FIBER OPTIC NETWORK AND ASSOCIATED METHOD

RELATED APPLICATION

This application is a continuation of U.S. patent application Ser. No. 11/615,444, filed on Dec. 22, 2006, the disclosure of which is incorporated herein by reference.

BACKGROUND

The needs of law enforcement sometime require access to communications originating from or received by a target, such as an individual suspected of engaging in criminal activity. The communications may take place in various forms, including regular and electronic mail, face-to-face conversations, and communications transmitted over telephone lines, such as telephone conversations and facsimile transmissions. When law enforcement officials are legally authorized to intercept and monitor such communications, for example when a court order authorizing a wiretap on a target's telephone line has been issued, it is important that the officials can gain access to such communications without putting the target on notice that he or she is under surveillance.

In the context of telephone communications, legacy telephone line surveillance devices require an analog access point for lawful intercept monitoring. The monitoring device is typically connected to an analog, or "Tip and Ring," circuit. In the traditional Plain Old Telephone Service (POTS) architecture, telephone service is generally provided by extending a pair of metallic wires, such as copper wires, from a central office to a subscriber's premises. Access points, such as connections provided by cross boxes and local terminals, are typically provided along the circuit between the central office and the subscriber's premises. These access points allow for a monitoring device to be installed in a strategic location along the analog circuit between the central office and a target's premises, such as a location close to the central office where the target would not be aware of the installation or the fact that the target is under surveillance.

Traditional POTS architecture, however, is increasingly being replaced by fiber optic networks, such as Fiber to the Premises (FTTP) architecture, which use fiber optic cable instead of metallic cable to connect a subscriber's premises to the central office and provide telephone service. In a FTTP system, telephonic communications may be digitized and bundled for transmission over the fiber optic cable. In this way, communications received by the central office for transmission to a subscriber, such as communications destined for the target, no longer have a dedicated circuit over which the signals are transmitted. Rather, the digital data bundles are dynamically assigned to communication pathways between the central office and the target's premises. Such dynamic assignment of pathways allows the telephone service provider to use the communications network more efficiently to transmit signals; however, the dynamic assignment also presents obstacles to lawful surveillance of a target's communications as intercepting the signals propagating via one circuit no longer correlates to intercepting only one subscriber's communications.

The replacement of traditional metallic cable with optical fibers has also eliminated the analog access points that are generally required for the installation of lawful intercept monitoring devices. Although the optical fiber extending to the subscriber's premises is generally terminated in an optical network terminal (ONT) at the subscriber location, where the communication pathway may transition to metallic cable once again, installation of the lawful intercept monitoring device at the target's ONT may be visible to the target and may thus alert the target that he or she is under surveillance, thereby defeating the purpose of the surveillance.

Therefore, there exists a need for systems and methods of lawfully intercepting and monitoring telephonic communications to and from a target receiving telephone service over a fiber optic network in a way that is transparent to the target and does not alert the target that he or she is under surveillance.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

FIG. **1** is a schematic representation of one embodiment of the system for intercepting signals transmitted between a target served by a fiber optic network and a subscriber;

FIG. **2** is a schematic representation of one embodiment of the system for intercepting signals including a channel bank;

FIG. **3** is a schematic representation of one embodiment of the system for intercepting signals including an optical line terminal having first and second terminal interface cards;

FIG. **4** is a flow chart illustrating embodiments of a method of intercepting signals between a target served by a fiber optic network and a subscriber;

FIG. **5** is a flow chart illustrating one embodiment of a method of intercepting signals; and

FIG. **6** is a flow chart illustrating another embodiment of a method of intercepting signals.

DETAILED DESCRIPTION

Exemplary embodiments now will be described hereinafter with reference to the accompanying drawings, in which exemplary embodiments and examples are shown. Like numbers refer to like elements throughout.

Systems and methods for intercepting signals transmitted between a target served by a fiber optic network, such as a fiber to the premises (FTTP) network, and a subscriber (i.e., a subscriber served by the same network or a different network) are provided in accordance with various exemplary embodiments. An exemplary network includes a central office phone switch configured to convey communication signals to and from a subscriber, also referred to as a target in instances in which communications with the subscriber are to be intercepted. Target communications are assigned to an analog circuit at the central office, and a monitoring device installed along the analog circuit and situated proximate the central office is configured to intercept the communications, for example for surveillance by law enforcement. Advantageously, intercepting and monitoring of communications to and from the target are accomplished without notifying the target that he or she is under surveillance.

Referring to FIG. **1**, embodiments of the system **10** comprise a phone switch **12** located at a central office **11**, a monitoring device **14**, and an optical line terminal (OLT) **16** located at the central office **11**. The OLT **16** is configured to serve as a point of origination for a signal coming into or going out of the fiber optic network, and the phone switch **12** is configured to communicate with the fiber optic network via the OLT **16**. An analog circuit **26**, such as a circuit formed by conventional metallic cables, is disposed at a location between the phone switch and the optical line terminal such that the signal transmitted between a target **18** and a subscriber is propagated along the analog circuit **26**, and the

monitoring device **14** is configured to monitor the signal while the signal is propagating along the analog circuit **26**.

Although the system **10** is configured to provide for the interception and monitoring of communication signals both transmitted from a subscriber to the target **18** as well as from the target **18** to a subscriber, communications involving the target as a recipient will be used in most of the examples that follow to facilitate a discussion of the embodiments. It is understood that such examples describing communication transmitted from the target to a subscriber in no way limit the application of these embodiments to communications transmitted from a subscriber to the target.

In communications involving the target as a recipient, the phone switch **12** is configured to receive a signal to be transmitted over a fiber optic network to the target **18**. Although the signal is thereafter destined to be transmitted at least partially over a fiber optic network, the phone switch **12** typically receives the signal via conventional metallic cables. A communication pathway **20**, also typically formed by metallic cables, connects the phone switch **12** to the target **18** through the OLT **16**. The OLT **16** is configured to convert the signal to an optical signal for transmission over the fiber optic network. An optical network terminal (ONT) **22** may also be disposed between the OLT **16** and the target **18**, typically at the target's premises, and may be configured to convert the signal transmitted via the fiber optic network from an optical signal to an analog signal to be transmitted over metallic cables to the telephone equipment of the target **18**.

In order for the monitoring device **14** to monitor the communications of a particular target **18**, the dynamic assignment of a communication pathway **20** at the phone switch **12** must be bypassed or overcome to allow for a dedicated analog circuit to be created between an access point **24**, to which the monitoring device **14** is connected, and the target **18**. The signal received at the central office **11** is assigned to an analog circuit **26** in different ways according to the type of equipment installed along the communication pathway **20**. In one embodiment shown in FIG. **2**, the assignment of the signal to a particular analog circuit **26** is made at the phone switch **12** and the OLT **16**. More specifically, a signal received at the phone switch **12** to be transmitted to the target **18** would be assigned to the analog circuit **26**, such as an analog POTS Line Equipment circuit, at the phone switch **16**. Similarly, a signal received at the OLT **16** originating from the target **18** would be assigned to the analog circuit **26** at the OLT **16**. In another embodiment, shown in FIG. **3**, the assignment of the signal to a particular analog circuit **26** is made at the OLT **16**. For example, a signal received at the phone switch **12** to be transmitted to the target **18** would be propagated to the OLT **16**, where the assignment of the signal to the particular analog circuit **26** would be made.

Regardless of where the signal received at the central office **11** is assigned to an analog circuit **26**, the monitoring device **14** is configured to monitor the signal while the signal is propagating along the analog circuit **26**. The monitoring device **14** intercepts the signal via an access point **24**, which may be provided by a cross box such as a cross connect box, a Subscriber Access Cabinet (SAC), a Subscriber Access Panel (SAP), or other similar device. In general, the monitoring device **14** may be disposed along and in communication with the analog circuit **26** at a location outside the central office **11** in accordance with statutes prohibiting the monitoring of communication within a central office. For example, the monitoring device **14** may be connected to a cross box located just outside the walls of the central office **11**, but still proximate the central office **11** such that the target **18** is unaware that he or she is under surveillance.

According to one embodiment of the system **10** illustrated in FIG. **2**, such as a FTTP system with a T1 only interface, the signal received by the phone switch **12** at the central office **11** may be assigned to an analog circuit **26** at the phone switch **12**. The monitoring device **14** may be disposed along the analog circuit **26** at an access point **24** located between the phone switch **12** and the OLT **16**. For example, the signal may be propagated along the analog circuit **26** from the phone switch **12**, which may be a Class 5 Switch, to a cross box connecting a monitoring device **14** to the analog circuit **26**. The monitoring device **14** may thus intercept and monitor the signal propagating along the analog circuit **26** via the connection at the cross box. The analog circuit **26** may then extend from the cross box, where the signal was monitored by the monitoring device **14**, to terminate within a channel bank **28**. The channel bank **28** may be configured to convert the POTS signal propagating along the analog circuit to a digital signal that is propagated to the OLT **16**. The channel bank **28** may be, for example, a D4 type channel bank that is configured to convert the POTS signal to a T1/D1 signal. The D4 type channel bank may be configured to embed the analog signal into a T1 output of the channel bank. The channel bank **28** may further include a Foreign Exchange Office (FXO) type plug-in configured to terminate the analog circuit **26**. The digital signal from the channel bank **28** may then propagate to the OLT **16**, where the signal may be converted to an optical signal to be propagated to the target **18** via the optical fiber network, as previously mentioned. For example, internal provisioning within the OLT **16** may establish the analog POTS circuit connection from the channel bank **28** to the ONT **22** located at the target's premises. Similarly, signals received at the OLT **16** originating from the target **18** may be propagated to the analog circuit **26** for interception and monitoring.

In another embodiment, illustrated in FIG. **3**, the signal received at the central office **11** is assigned to the analog circuit **26** at the OLT **16**. Considering communications to be transmitted to the target **18** as a recipient, the signal received at the phone switch **12** is propagated along a dynamically assigned digital circuit, such as a T1 circuit, from the phone switch **12** to the OLT **16**. The OLT **16**, which may have a DS0 interface, for example, may have first and second terminal interface cards **30**, **31** installed within the OLT **16**. The target's signal may be isolated or "stripped out" within the OLT **16** and assigned to a particular analog circuit **26**. The analog circuit **26** may then be routed from the first terminal interface card **30** to an access point **24**, such as a cross box, where a connected monitoring device **14** may intercept the POTS analog signal and monitor the communication. The analog circuit **26** may then be routed from the monitoring device **14** back to the OLT **16**, where it may terminate onto the second terminal interface card **31**.

For example, a copper pair of conductors may extend from the first terminal interface card **30** to the cross box, where the signal may be intercepted and monitored by the monitoring device **14**, and then extend back to the second terminal interface card **31** in the OLT **16**. The first terminal interface card **30** may be, for example, a Remote Universal Voice Grade (RUVG) card or a Remote Plain Old Telephone Service (RPOTS) card. Similarly, the second terminal interface card **31** may be, for example, a Local Universal Voice Grade (LUVG) card or a Local Plain Old Telephone Service (LPOTS) card. RUVG and LUVG cards may be advantageous in some implementations relative to RPOTS and LPOTS cards because of the capability to option the transmit and receive levels of the circuit to allow for better monitoring of the communication. Alternatively, in systems including an ONT **22** at the target premises, the transmit and receive levels

may also be optioned at the ONT **22**. Optioning the transmit and receive levels adjusts the quality of service provided to a subscriber, making the audible level of conversation, echo, and other voice quality features appear normal. Generally, optioning the transmit and receive levels is only necessary for very long circuits, such as when a subscriber is located 20,000 feet from the central office. As previously mentioned, typically the access point **24** is located close to the central office **11**, and as a result optioning the transmit and receive levels is generally not necessary for receiving quality transmissions at the monitoring device **14**.

Once again, signals received at the OLT **16** originating from the target **18** may also be assigned to a particular analog circuit **26** in a similar manner. Thus communications originated by the target **18** may also be intercepted along the analog circuit **26**.

A method is also provided for intercepting a signal to be transmitted between a target served by a fiber optic network and a subscriber without alerting the target that he or she is under surveillance. Referring to FIG. **4**, a signal transmitted between a target and a subscriber of a fiber optic network is initially received at a central office. The signal is then assigned to an analog circuit, the signal is monitored while the signal propagates along the analog circuit, and then the signal that has been transmitted via the analog circuit is converted, after it is monitored, to a digital signal for transmission from the central office such as to the target over a fiber optic network. See FIG. **4**, blocks **100-106**.

In one embodiment, monitoring the signal may involve propagating the signal along the analog circuit from within the central office to a location outside the central office (for example, just outside the central office), monitoring the signal while the signal propagates along the analog circuit at the location outside the central office, and then propagating the signal along the analog circuit back into the central office after the signal has been monitored. See blocks **108-112**. Propagating the signal to a location outside the central office for monitoring may be done, for example, to comply with laws prohibiting the monitoring of communications inside the central office.

Depending on the type of equipment installed along the communication pathway between the central office and the target, the signal may be assigned to the analog circuit in different ways. Referring to FIG. **5** and considering communication to be received by the target, the signal may be propagated to an OLT after the signal has both been assigned to an analog circuit and monitored by the monitoring device. See block **114**. Furthermore, the signal may be propagated to a channel bank after the signal has been assigned to an analog circuit and has been monitored, as previously described and illustrated in FIG. **2**. For example, in a FTTP system with a T1 only interface, the POTS signal propagating along an analog circuit may be routed from a phone switch to a cross box with a connected monitoring device, then to a channel bank, such as a D4 type channel bank. The channel bank may further convert the POTS analog signal to a digitally multiplexed data signal prior to propagating the signal to the OLT. See blocks **116-118**. Although not shown in FIG. **4**, a communication signal originating with the target may likewise be propagated to a channel bank, after being propagated to an optical line terminal and assigned to the analog circuit and before being monitored, where the signal may be converted from a digitally multiplexed data signal to an analog signal. The signal may then be propagated to a phone switch for transmission to a subscriber recipient.

Alternatively, when the communications system includes an OLT having a DS0 interface, the signal received at the central office may be propagated to the OLT prior to assigning the signal to an analog circuit. See FIG. **6**, block **120**. In the case where the signal is propagated to the OLT before assignment to an analog circuit, the signal is isolated or "stripped out" within the OLT before it is routed to the monitoring device, then routed back to the OLT. If the target is a recipient, as shown in FIG. **6**, the signal is converted to an optical signal and transmitted to the target, as previously described and illustrated in FIG. **3**. If the target is an originator of the communication, the signal is transmitted to the subscriber recipient.

In the preceding specification, various embodiments of the claimed invention have been described. It will, however, be evident that various modifications and changes may be made thereunto without departing from the broader spirit and scope of the invention as set forth in the claims that follow. The specification and drawings are accordingly to be regarded in an illustrative rather than restrictive sense.

That which is claimed:

1. A method comprising:

receiving, by a communications device at a central office, a signal associated with a target served by a fiber optic network;

assigning, by the communications device, the signal to an analog circuit, where the signal is monitored while the signal propagates along the analog circuit, where assigning the signal to the analog circuit further includes:

directing, through the analog circuit, the signal to a location outside of the central office, where the signal is monitored while the signal propagates along the analog circuit outside of the central office, and

directing, through the analog circuit and after monitoring, the signal back to the central office;

receiving, by the communications device, the signal from the analog circuit; and

transmitting, by the communications device and via a digital circuit, the signal, received from the analog circuit, from the central office.

2. The method of claim **1**, further comprising:

propagating the signal to an optical line terminal after monitoring the analog signal.

3. The method of claim **2**, further comprising:

propagating the signal to a channel bank after assigning the signal to the analog circuit and monitoring the signal prior to propagating the signal to the optical line terminal.

4. The method of claim **3**, further comprising:

converting, after assigning the signal to the analog circuit and prior to propagating the signal to the optical line terminal, the signal to a digitally multiplexed data signal.

5. The method of claim **1**, further comprising:

propagating, after propagating the signal to an optical line terminal and after assigning the signal to the analog circuit, the signal to a channel bank.

6. The method of claim **5**, further comprising:

recovering, after propagating the signal to an optical line terminal, the signal; and

assigning, after recovering the signal, the signal to the analog circuit.

7. The method of claim **1**, further comprising:

propagating the signal to a phone switch after assigning the signal to the analog circuit.

8. The method of claim **1**, further comprising:

propagating the signal, received at the central office, to an optical line terminal at the central office prior to assigning the signal to the analog circuit.

9. An apparatus comprising:
means for receiving, at a central office, a signal associated with a target, served by a fiber optic network, where the signal is propagated on an optical line terminal;
means for assigning the signal to an analog circuit, in response to the signal being received;
where the assigning means include:
means for directing, through the analog circuit, the signal to a location outside of the central office, where the signal is monitored, by monitoring means, while the signal propagates along the analog circuit outside of the central office, and
means for directing, through the analog circuit and after monitoring, the signal back to the central office;
means for receiving the signal from the analog circuit; and
means for transmitting the signal, received from the analog circuit, from the central office.

10. The apparatus of claim 9, further comprising:
means for converting, after assigning the signal to the analog circuit and prior to propagating the signal to the optical line terminal, the signal to a digitally multiplexed data signal.

11. A device comprising;
a processor to:
receive a signal associated with a target served by a fiber optic network, where the device is located at the central office;
assign the signal to an analog circuit, where the signal is monitored while the signal propagates along the analog circuit, where the processor, when assigning the signal to the analog circuit, is further to:
direct, through the analog circuit, the signal to a location outside of the central office, where the signal is monitored, by a monitoring device, while the signal propagates along the analog circuit outside of the central office, and
direct, through the analog circuit and after monitoring, the signal back to the central office;
receive the signal from the analog circuit; and
transmit, via a digital circuit, the signal, received from the analog circuit, from the central office.

12. The device of claim 11, further comprising:
a cross box coupled to the processor, where the cross box connects the monitoring device to the analog circuit.

13. The device of claim 12, where the cross box is located at the central office.

14. The device of claim 13, where the monitoring device is disposed outside of the central office.

15. The device of claim 11, further comprising:
a channel bank to convert the signal between a digital representation of the signal received on the fiber optic network and an analog representation of the signal propagated on the analog circuit.

16. The device of claim 15, where the channel bank includes a Foreign Exchange Office type plug-in to terminate the analog circuit.

17. The device of claim 15, where the signal is propagated to the channel bank after the signal is received at the device, and prior to the monitoring device monitoring the signal.

18. The device of claim 11, further comprising:
a first terminal interface card, and
a second terminal interface card,
where the analog circuit routes the signal from the first terminal interface card to the monitoring device, and from the monitoring device to the second terminal interface card.

19. The device of claim 18, where the first terminal interface card comprises one of a Remote Universal Voice Grade card or a Remote Plain Old Telephone Service card.

20. The device of claim 18, where the second terminal interface card comprises one of a Local Universal Voice Grade card or a Local Plain Old Telephone Service card.

* * * * *